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USSR REPORT

Economic Affairs

No. 892

Contents PAGE

INTEGRATED SOCIOECONOMIC DEVELOPMENT OF CENTRAL ASIA, SIBERIA DISCUSSED

Tashkent KOMMUNIST UZBEKISTANA in Russian No 6, 1979 pp 14-21

[Article by M. Abdusalyamov, candidate of economic sciences: "Issues of Interregional Cooperation and Integration of Central Asia, Kazakhstan and Siberia"]

[Text] The 25th CPSU Congress worked out the fundamental guidelines for the accelerated development of natural resources and the growth of economic potential in the eastern regions of the country. The following targets were set for the period of the Tenth Five-Year Plan: a 1.5-fold increase shall be achieved in the volume of industrial production in these regions; the entire increase planned for 1976-1980 in the yield of petroleum and gas and the production of aluminum shall be provided by these regions; they shall also provide more than 90 percent of the increase in coal mining and approximately 80 percent of the increase in copper production, as well as 45 percent of the cellulose and about 60 percent of the cardboard production increases.

The rapid rate of economic development in the eastern regions is the result of the objective need for the utilization of their enormous natural resources and potential in the interests of the entire country. These regions have nearly 90 percent of the nation's total fuel and energy resources, about 80 percent of the forests, more than half of the predicted reserves of non-ferrous metal ores and of chemical and aluminum raw materials, a significant portion of the iron ore reserves, and the bulk of the raw materials for light industry, etc. National production on the necessary scale cannot be achieved without putting these resources into economic circulation.

At the same time the successful realization of the targets for the development of natural resources in the eastern regions is beginning to depend to an ever greater degree on the rational division of labor among these regions. It is becoming essential to have not only a differentiated approach to the problems of developing each region, but also improvements in their economic ties and a program for implementing close cooperation in production and integration primarily in Siberia, Central Asia and Kazakhstan.

These problems are of particular interest to Central Asia. In recent years this region's links with the other above-mentioned regions have developed in the following manner: Siberia supplies Central Asia with forestry products, ferrous metals, coal, petroleum and petroleum products, machine tools, products of the chemical, light and food industries, instruments, electronics, various engines, road and construction equipment, etc. And in turn, Central Asia ships to Siberia cotton, vegetable oil, grapes, vegetables and melons, fruit, canned fruit and vegetables, wine and viticulture materials, chemical industry products, petroleum products, various types of equipment, instruments, forge-and-pressing machines, cable products, equipment and vehicles for road work (scrapers, excavators, etc.).

However, the shipments from Siberia to Central Asia are dominated by large, heavy loads, while it is mainly lightweight cargo (which may also be expensive) which moves in the other direction. For this reason the railway transport balance for 1975, to take an example, showed a cargo exchange ratio between Siberia and Central Asia (in tonnage) of 6:1. (In 1966 the ratio was 5:1.) This first figure includes a ratio of 4.4:1 with Western Siberia and 9.3:1 for Eastern Siberia. It goes without saying that the further expansion of the economic ties between these two regions will be accompanied by growth in the volumes of reciprocal deliveries. However, the freight exchange balance between Central Asia and Siberia is likely to remain in favor of the Central Asian republics due to the sharp differences which will remain in the structure of the goods being exchanged.

Central Asia also has extremely close economic ties with Kazkhstan. These ties have deep roots and result from the entire course of the historical development of the fraternal peoples who inhabit these regions. Kazakhstan leads all other economic regions of the country in terms of freight turnover with the republics of Central Asia. At present Kazakhstan takes more than 38 percent of the total volume of freight which is shipped from Central Asia, and it supplies more than 41 percent of what goes into Central Asia. Kazakhstan supplies Central Asia with the bulk of the coal and chemical fertilizers which come from other regions of the USSR; it is also responsible for a significant fraction of the ferrous metals, petroleum products and machine building output, as well as a substantial amount of the wheat, meat and meat products. The Central Asian republics ship to Kazkhstan products of non-ferrous and ferrous metallurgy, machine building and the chemical industry, and they transmit to Kazakhstan a significant portion of their electrical energy. The republics of Central Asia supply Kazakhstan with large amounts of cotton fiber, as well as fruits and vegetables, vegetable oil, etc.

It is natural that the economic ties among Siberia, Central Asia and Kazakhstan will be still further developed and improved in the future in accordance with national economic targets. At the same time these ties, which are based on the practical need to exchange goods which reflect economic specialization, will exert an enormous influence on

the economy of each of these regions, but they will not lead to profound qualitative changes in the structures of their economies because they do not adequately taken into account the opportunities which exist for close cooperation.

A better way to develop the productive forces of these regions must be determined primarily by the interests which our entire nation has in the comprehensive development of these natural resources and in the expansion of the economic potential which exists here. For it is in these regions that the solutions will be found to the problems of realizing the major comprehensive programs of inter-sectorial and inter-regional significance, programs which go beyond the limits of our current century. and which require enormous resources. To a significant degree this determines the basic trends in the development of the region's economy. The following may be included in these trends: the establishment of national fuel and energy bases; the formation of ferrous metallurgy and machine building bases; the development of the USSR's largest energy-intensive production units of the chemical and petrochemical industries and of non-ferrous metallurgy; the establishment of another food-producing area for the nation;and the diversion of some of the Siberian river flow into the basin of the Aral Sea.

Each of these problems requires for its realization the territory and resources of practically all of the eastern regions; for this reason it makes sense to examine them as a single object for planning and prediction and for the development of comprehensive programs. This kind of approach, while expanding the horizons for planning and aiming the plans at economic end results, will make it possible not only to solve in a comprehensive manner the complex problems of economic and scientific-technical cooperation among these regions but also to ensure temporal coordination in accordance with common interests and plans for the development of the nation's economy.

The soundness of this approach also derives from the fact that the present intensive growth in the economic potential of the eastern regions offers the most favorable opportunities to carry out here major economic programs and to conduct economic and technical experiments through the effective redistribution of capital investments in the various economic sectors and territories and through special purpose inter-sectorial and regional programs.

The inadequate level of development in the productive forces of the eastern regions and the differences in these forces as they exist in each of the regions also dictate the need for close cooperation in solving complex economic tasks and in coordinating long-range plans.

All of these questions are exceptionally timely for the republics of Central Asia, and for Uzbekistan in particular, because the situations which are developing in regard to supplies of certain types of natural

resources, as well as demographic and economic conditions puts these republics in a special position in the system of the eastern regions. It is important for Central Asia to have a comprehensive approach to the solution of water-supply and fuel-and-energy-supply problems, as well as the problem of how to make rational use of labor resources, inasmuch as these problems determine in the greatest measure the future trends in Central's Asia's socio-economic development. We shall examine the main premises of the most important of these for Central Asia.

Partial Diversion of Water from the Siberian Rivers into the Basin of the Aral Sea. In the economic literature and in scientific studies sufficient attention has been devoted to this problem, which is complex and grandiose in scale and which has no equal among similar problems which are being solved at the present time. It is worth focussing only on certain aspects of the problem.

It has already been shown that without diverting some of the water from Siberian rivers into the basin of the Aral Sea there will be no possibility of acclerated development for the economy of Central Asia in the near future. The effective utilization of agricultural lands in a significant portion of Siberia and Kazakhstan also depends very closely on the implementation of this program. At the present time the shortfalls of agricultural products in bad years are reaching significant amount in those regions of Kazkhstan which are most subject to drought and in the Kulundinskaya and Barabinskaya steppes.

Diversion of Siberian water will make it possible to use more effectively the irrigation area and to develop about 20 million more hectares in Central Asia and Siberia; it will also solve a global problem by creating a major new food-producing area in the nation's East. The southern part of Western Siberia, Kazakhstan and Central Asia (Uzbekistan) have the most favorable conditions for the siting of grain farms in comparison with all the possible zones for growing these crops. The water of Siberia will ensure a sharp increase in the production of cotton, which will be grown on a scale to completely satisfy the nation's needs; with this water there will be in this area another source of an enormous amount of high-quality wheat, as well as one of the world's largest bases for the production of grain.

The realization of the plan to divert the waters of Siberian rivers is also related to the construction of a new water-transportation artery, which will use a system of deep-water canals to connect the Ob' and the Irtysh with the Syr Dar'ya and the Amu Dar'ya; this artery will carry a significant amount of the freight moved between Siberia, Kazakhstan and Central Asia.

A final result of the diversion of Siberian rivers will be the organization of a major new meridional zone for economic development in

the Asian USSR and the emergence of major new industrial centers here. This will lead to substantial changes in the industrial structure of the economy in the eastern regions; it will provide a powerful new stimulus to the productive forces of the nation, and it will increase the role of the USSR in the world economy,

The Utilization of Labor Resources. With the exception of Central Asia, all the eastern regions of the Soviet Union have a growing shortage of labor resources, which will continue in the foreseeable future. In the next decade the Central Asian republics, according to calculations made by the Council for the Study of Productive Forces (CSPF) of USSR Gosplan, will provide nearly two-thirds of the increase in the able-bodied population of the country, and this requires that an appropriate demographic policy be carried out here and that forms for the siting of productive forces be selected. In Central Asia, as in no other economic region of the USSR, the rational utilization of labor resources at the present and in the future is acquiring extreme urgency.

From the viewpoint of long-range strategy the rapid growth of population in the Central Asian republics should be viewed as a most valuable national reserve for the future socioeconomic development of the country and primarily of its eastern regions. However, as a result of the low rate of migratory mobility of the Central Asian population it cannot be expected that there will be any substantial participation in the near future by its labor resources in the public production of Siberia and Kazakhstan.

Under these conditions it is becoming possible and advisable--given the necessary organization of vocational training for personnel--to call for siting in Central Asia (mainly in Uzbekistan) a number of major production units which are labor intensive; this may involve shifting the base of material resources from other regions. In this regard it is important to have broad utilization of the various forms of production cooperation in the Eastern regions, especially between Siberia and Central Asia, in various industries; with this cooperation a significant portion of the labor load in bringing raw materials and intermediate products into the processes for manufacturing end products will also be shifted to the Central Asian republics. And in turn this would make it possible to make more rational use of the labor resources of Siberia and Kazakhstan in those sectors of the national economy in which regional conditions are favorable to development and which produce goods which the nation most needs.

The Utilization of Fuel and Energy Resources. It is now clear that the future growth of our nation's economic potential will be largely determined by the rate and direction of the development experienced by the various sectors of the fuel and energy complex of the Eastern regions, especially in Siberia and Kazakhstan. Although Central Asia is relatively well supplied with fuel and energy resources, the reserves of these resources are vastly inferior to those of other eastern regions. The Central Asian republics, especially Uzbekistan, will experience shortages of these

resources in the near future; this means, on the one hand, that it is necessary to limit the siting of energy-intensive production units here and, on the other hand, that it is important to look for additional sources which can be obtained by increasing the consumption of local natural gas and petroleum and by bringing in from other regions, mainly from Siberia and Kazakhstan, various forms of fuel and energy to replace them. In this regard the following are of particular interest to Central Asia: the development of enormous reserves of natural gas and petroleum in Western Siberia, and the coal of the Kuznetsk Basin, the formation and development of the Kansko-Achinskiy and Ekibastuzskiy fuel and energy complexes; increases in coal mining in the Karaganda Basin, and the growth of petroleum refining and the production of electrical energy in Kazakhstan.

The further development of the fuel and energy economies of Siberia, Kazakhstan and Central Asia and the utilization of the resources of these regions to ensure that national programs are met constitute interrelated tasks. For this reason it is advisable to examine them within the framework of a single complex established for the entire region; this will make it possible for these regions to solve as well the problems of how to most effectively develop reciprocal fuel and energy balances. The plans to begin supplying Central Asia in the near future with Western Siberian oil by means of the Omsk-Pavlodar-Chimkent-Chardzhou oil pipeline should be considered one of the first steps in this direction.

Ferrous Metallurgy. It has entered a new phase of its development--the transition from an orientation towards a qualitative increase in production to working to improve the qualitative characteristics of the metal products which are being turned out; this has been accompanied by a profound restructuring of the entire industry. This tendency was manifested with particular clarity in the preceding five-year plan; it has been increasing in the Tenth Five-Year Plan, and it will undoubtedly continue in the future.

At the same time increasing the effectiveness of ferrous metallurgy in our country requires the solution of a number of questions of territorial organization and location of the enterprises of this industry, especially in the eastern regions, and the coordination of these problems with the targets for the development of their economies. The problem is that in these regions the consumption of ferrous metals is currently much greater than production, and this trend is growing. The third and fourth national metallurgical bases, which are being formed in Siberia and Kazkhstan, and which are supposed to supply most of the remaining needs of the astern regions for ferrous metals, have still not been completed, although these regions have the best conditions in the country for this.

In Central Asia, where prospects for the development of ferrous metallurgy are quite limited, the situation is different. At the present time an electro-metallurgical complex is being built as part of the Uzbek Metallurgical Combine. This will make it possible to increase the republic's steel production by nearly 3-fold in comparison with the present level. In order to expand electrical steel smelting in Central Asia the CSPF of Gosplan USSR and the CSPF of the Uzbek SSR Academy of Sciences have proposed the construction here of two small plants which would produce high-quality steel from local scrap metal. However, the implementation of this proposal will still not solve the problem of how to meet Central Asia's need for ferrous metals through the use of internal resources.

For this reason it is important--when solving the problem of the further development of ferrous metallurgy in Siberia and Kazakhstan--to take into consideration the interests of Central Asia, and to carry out interregional specialization and production cooperation within this industry from a united regional perspective. In particular, it is advisable to pose the question of expanding the production of ferrous metal rolled products in the Central Asian republics; this would depend not only on internal resources but also on external resources (such as steel brought in from Kazakhstan, Siberia and possibly the Kursk magnetic anomaly in the form of slabs and bars). As the water and energy problems are solved, there is the future possibility of siting in Central Asia a major meltallurgical plant based on the utilization of metallized pellets (with a metal content of more than 70 percent) which can be brought in from the regions of the Kursk magnetic anomaly and Kazakhstan.

However, consideration should be given to the extreme complexity involved in the establishment of ferrous metallurgy industries, to their high capital-intensiveness and their enormous influence on the economy of the regions where they are located, an influence which is exerted over an extended period of time. For this reason the projected development of ferrous metallurgy, more than the development of any other sector of the national economy, must be based first of all on national interests and demands, and it must be worked out with careful consideration for the prospects before it in other regions of the country. However, under any circumstances the establishment of a stable and large-scale base to supply Central Asia with ferrous metals would be a powerful stimulus for the construction here of a major national center for machine building and metal working and for an increase in the output of various rolled products, hardware and pipes, the production volumes of which are still low at the present time. Also, the variety of goods shows inadequate consideration for regional demands.

The Petrochemical Industry. In the economic relations of the eastern regions, and primarily of Siberia and Central Asia, opportunities for cooperation in the area of petrochemistry have a particularly important

role. It should be said that Siberia now has a sufficiently powerful base for the petrochemical industry and in the future it will become one of the major petrochemical centers in the USSR. The output of this sector has not only national significance: a large amount of the output is supplied as well to the world market.

Central Asia has at its disposal significant resources of hydrocarbon raw materials, and this creates favorable conditions for the development here of a number of petrochemical production units such as plants to produce synthetic resins and artificial fibers, plastics, rubber, etc. However, this process is moderated and in the future will be limited by a shortage of water and electrical energy resources, as well as by a lack of free land areas which are essential for siting the appropriate enterprises.

Before the problem of diverting part of the Siberian river flow is solved, the petrochemical industry of Central Asia could be oriented to a certain degree toward the processing of the most energy-intensive and water-intensive intermediate products—obtained from Siberia—into end products. And, in turn, this form of cooperation would make it possible to develop at an accelerated rate a complex of production units for the electrotechnical and construction industries, as well as to increase the output of machine parts, thermal insulation and finishing materials, sanitary engineering equipment and consumer goods.

In a similar way the problem of production cooperation with Siberia in the development of the woodworking industry is of great interest to Central Asia. At the present time the nation's largest forest industry complexes are being established in Siberia; they will process up to 15 m^3 of wood per year or more. It is planned to send a significant fraction of the output to Central Asia. Under these conditions it is advisable to have a form of production cooperation among these regions which calls for the republics of Central Asia to be supplied mostly with intermediate products which require relatively small amounts of labor. The most labor-intensive operations, which involve bringing products to the final consumption stage (carpentry items, furniture, etc.) could be better established at large-scale specialized assembly and finishing enterprises in the Central Asian republics.

This kind of interregional cooperation would predetermine a deeper orientation on the part of the forest industry complexes of Siberia towards the satisfaction of Central Asia's needs for specific products, and it would contribute to an increase in the effective utilization of forest resources and the processing of waste products. The latter would create the conditions for the establishment in Central Asia of a major center for the woodworking industry; the center would be based on the production and technological cooperation with the forest industry complexes of Siberia, and it would have interregional significance.

The Production of Consumer Goods. In terms of the various resources needed to expand production of goods for which there is large-scale demand the eastern regions are in a favorable position. However, in terms of opportunities for the realization of these resources the regions differ from each other substantially. In particular, Central Asia is in the best position to increase the output of consumer goods; moreover, it can supply many of these goods to other regions of the country. For this reason it is now important to clearly determine which zones have the supplies and which have the steady consumers for these products.

It is expected that the demand of the Eastern regions for cotton cloth will total nearly 3.5 billion linear meters. Central Asia has good conditions for increasing the production of this cloth. The output in Central Asia may be brought to 1.5-2 billion linear meters (as opposed to 423 million in 1975), of which 450-600 million may be supplied to other regions of the country, including Siberia. A clear orientation of this kind will make it possible to significantly reduce transport expenses. For example, the cost of transporting one ton of textiles from Ivanovo to Novosibirsk is 1.5-fold higher than the cost of bringing it from Tashkent.

Central Asia may also become for Siberia a major supplier of the most labor intensive knitted goods and other items of clothing, as well as refrigerators, washing machines and other household equipment.

Within the framework of production and technological cooperation between the two regions, Siberia, as we have already noted, could supply Central Asia with semi-finished furniture for subsequent assembly and finishing at major specialized furniture assembly and finishing enterprises. There is no doubt that this option would be beneficial. The production of semi-finished furniture is not labor-intensive, it is carried out at highly mechanized enterprises and the output can be easily transported. Shipping the intermediate product costs 8-10 times less than delivering the wood or the finished furniture.

The economic ties between the two regions may find the fullest form of their expression in reciprocal deliveries of agricultural products, in the establishment of a distinctive "green bridge" between Central Asia and Siberia.

Due to natural conditions the demands of the Siberian population for melons, grapes and other fruits, as well as much of the demand for vegetables, must be satisfied by other regions. Calculations show that by late 1980 it will be necessary to bring in up to 1.1 million tons of vegetables and melons, up to 1.6 million tons of grapes, fruits and berries, and by the end of the following decade it will be necessary to bring in 1.5 million tons and 2.6 million tons respectively.

In the meantime Central Asia does not contribute a large proportion of the fresh fruit and vegetable supplies which Siberia receives. However, the Central Asian republics must remain the nation's major producers of cotton, but they must also become the most significant base for the production of vegetables, melons, berries and other fruits in the East and the major supplier for the various parts of Siberia.

In turn Sibera can become a major supplier of its products to Central Asia. Calculations show that in the near future it will be in a position to meet all of Central Asia's demands for milk products, potatoes, and most of its demand for grain fodder. Siberia has immeasurably greater opportunities for this than does Central Asia. Deliveries of meat and meat products can grow substantially, as can deliveries of the "gifts" of the taiga--mushrooms and various forest fruits.

In order to resolve all these issues it is necessary to link more closely the prospects for the development of production and for consumption of food products in both regions. Specifically, this will make it possible to utilize more effectively the advantages of the agroindustrial complexes which are being established in both areas. We have in mind the expansion of the "green bridge" as a result of the implementation of a comprehensive special-purpose program to integrate development (the "green bridge" can function to an equal degree in both directions--with approximately 2 million tons of products per year). This program could serve as the foundation for the transition to the next stage--the development and realization of a comprehensive, special-purpose program to establish a single food base for the eastern regions of the country.

The problems which have been examined here constitute only a part of the broad range of issues in the long-range planning and prediction process for the development of the economy in these regions. However, it is clear that our interest in increasing the effective utilization of their resources makes it necessary to have close coordination in the process of formulating plans for the accelerated growth of the production forces here; this coordination would be based on principles of economic integration and would arise from the general strategy for increasing the economic potential of the nation's eastern regions.

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OVERCOMING DEVELOPMENTAL GAP BETWEEN TOWN AND COUNTRY

Moscow EKONOMICHESKAYA GAZETA in Russia No 34, Aug 79 p 10

[Article by A. Kandrenkov, first secretary of Kaluzhskiy CPSU Obkom and B. Arkhipov, head of Chair of Political Economy of Moscow of MVA [Moscow Veterinary Academy], candidate of economic sciences: "Town and Country: Ways of Drawing Together"]

[Text] The party's agrarian policy at the stage of developed socialism provides for a comprehensive approach to the solution of production and social problems of agricultural development. "Here," L.I. Brezhnev said in a report at the 25th CPSU Congress, "the party brings forth two interconnected aims. The first is to provide the country with a reliable supply of food and agricultural raw materials and always to maintain adequate reserves for this. The second goes even further along the path of bringing closer the material and cultural-everyday conditions in the life of town and country, which constitutes our program requirement."

Dynamic changes in productive forces and production relations dictate the need for further development of the theory and practice of overcoming social-economic differences between town and country.

The social-economic differences between town and country, as we know,boil down to different levels of development of productive forces of industry and agriculture, differences of two forms of socialist property and also differences in material and cultural-everyday conditions in the life of the urban and the rural population.

In scientific and popular literature two concepts are usually advanced: "essential differences," by which is meant different levels of social-economic development of industry (in the city) and agriculture (in the country), and "unessential differences." The latter frequently frequently boils down to technological features of industrial and agricultural production. At the same time it is understood that "essential differences" will be abolished in the process of building of communism, while "unessential" ones will be retained.

Identification of "essential differences" with social ones and of "unessential" ones with technological differences calls for objections. The village is gradually drawing closer to the city in the building of communism on the basis of the level of development of productive forces, economic relations and cultural-everyday conditions. Essential differences become less essential, remaining, however, social. In our opinion, it is inadmissable to speak of "unessential differences" as once and for always given technological differences of industry and agricultural production. The concept of "essential" and "unessential" differences as quantitatively and qualitatively definite indicators of the level of development of town and country makes it possible not only to express the extent of differences but also to direct the process of overcoming them.

Development of Productive Forces

The planned transition of agricultural production to an industrial basis creates material conditions for overcoming the differences between town and country.

The present stage of development of the USSR economy is characterized by an outstripping rate in the growth of the capital-labor ratio and the power-worker ratio in agriculture as compared to industry. Thus from 1965 to 1977, the power-worker ratio in industry increased 1.7-fold and in agriculture--2.6-fold. In Kaluzhskaya Oblast in 1965 the value of fixed production capital per each employed person amounts to 0.7 of the level of industry, while in 1978 it was 1.1. The power capacities per worker in the oblast's agriculture from 1965 to 1978 grew threefold and in industry--twofold.

The attainment of identical (or roughly identical) indicators for the capital- and power-worker ratios in industry and agriculture is not in our view the final solution to the problem of development of agricultural productive forces. World experience and calculations by specialists show that the power-worker ratio in agriculture should be higher than in the processing industry, considering the special features of agricultural production. The problem is not solely that it operates over tremendous spaces and that a significant part of the energy is spent on the movement of equipment and loads. It is important to complete agriculture work in optimal time periods, which requires a high level of technical equipment and power-worker ratio in this sector.

The July (1978) Plenum of the CPSU Central Committee worked out a large-scale program for the further development of the country's agriculture. Unceasing and rapid growth of the quantity and quality of new agricultural equipment, introduction of electricity and use of chemicals, improvement of the organization and technology of production, a broad program of land improvement and organic joining of science and production ensure a further raise in the level of development of the productive forces of agriculture and its transformation into a highly developed sector of the socialist economy.

Wide-scale scale introduction of machinery, chemical, biophysical and other methods of production means a revolution in the technical base of agricultural production, as well as in workers' functions. The conversion of agricultural labor into a variety of industrial labor is proceeding on this basis.

The experience of changing over agriculture to an industrial basis in Kaluzhskaya Oblast does disclose a number of difficulties together with positive factors. Industry is extremely slow in developing machinery for comprehensive mechanization of agricultural production even in its main sectors. The need for a system of machines is especially felt in plant growing, particularly in potato growing, flax growing and fodder production. There is so far no effective system of machines providing for flow-line harvesting, including the non-grain part of the harvest (straw, chaff).

The introduction of industrial methods of production in animal husbandry is being held back primarily by the slow rate of construction of modern livestock structures and renovation of animal-husbandry farms.

In connection with supplying agricultural production with increasingly complex equipment, it is necessary to raise significantly the skill level of machine specialists servicing this equipment. Specialists arriving at a kolkhoz or sovkhoz frequently do not have sufficient know-how. It would appear to be advantageous to undertake the training of specialists along more narrow lines but with deeper knowledge of skills needed in agricultural production on an industrial basis.

An important role in keeping cadres on farms is played by a complex of measures for creating a reliable material-technical base, modern working and living conditions and improving educational work. On such kolkhozes in Kaluzhskaya Oblasts as Mayak, imeni Marshal Zhukov and such sovkhozes as Vorsino, imeni V.N. Tsvetkov, well-appointed settlements have been created and production is well organized; graduates of secondary schools and vocational-technical schools eagerly stay on to work on these farms. Measures developed for keeping youth on farms by the oblast's party organization have produced positive results. More than a half of the secondary-school graduates stay on to work on the kolkhozes and sovkhozes.

An important direction in converting agricultural labor into a variety of industrial labor is agroindustrial integration, constituting an organic union of agricultural and industrial production connected with it.

A Growing Level of Collectivization

The drawing closer, and, in the long run, the fusion of the two basic forms of socialist ownership into a single national ownership is a logical result of the powerful development of productive forces in the period of building a communist society. This process includes the development of both forms of ownership: state and kolkhoz-cooperative, but the leading role belongs to the state form.

Kolkhoz-cooperative ownership is distinguished from state ownership first of all by the level of collectivization. The process of reproduction is to a greater extent than in kolkhozes under the influence of internal factors. Reimbursement and accumulation of productive capital, wages and housing construction are based on intrakolkhoz resources. This results in differentiation of the farms' levels of economic development.

Kolkhoz-cooperative ownership has sufficiently effective stimuli for its development as shown by the work of leading farms. The problem of fusing the two forms of ownership does not lie in the conversion of kolkhozes into sovkhozes but first of all in raising the level of collectivization of kolkhoz production and on this basis bringing the economic conditions of reproduction closer together on kolkhozes and sovkhozes. Such processes as growth of concentration of kolkhoz production, development of interkolkhoz and kolkhoz-sovkhoz associations, agroindustrial integration and improvement of intrakolkhoz relations are of major significance to the solution of this problem.

In Kaluzhskaya Oblast in the middle of 1979 there were 12 interkolkhoz and kolkhoz-sovkhoz production associations consisting of modern enterprises for the production of meat, milk, growing of pedigreed stock and fodder production.

Interfarm enterprises and associations as a rule have higher production indicators. Thus the Peremyshl'skiy Korma Interfarm Enterprise, because of a higher level of organization of fodder production, made it possible for the rayon's kolkhozes to increase in 1978 over 1972, the year of its establishment, gross production of milk by 29 percent versus 23 percent average for the oblast.

The economic requirements of socialist reproduction made necessary the creation and continuous development of mixed kolkhoz-state enterprise. This is one of the important directions in the fusion of the two forms of socialist ownership when economic relations become more mature.

A higher level of collectivized production and improved economic conditions in the operation of farms contribute to strengthening the economies of kolkhozes and sovkhozes. On this basis and also thanks to the constant concern of the state for improving the cultural-everyday services of rural workers and major voluntary assistance by city dwellers, historically created differences in material and cultural-everyday conditions in the life of the city and rural population are being overcome in the developed socialist society. This process is actively influencing the continued rise of agricultural production.

In his report to the July (1978) Plenum of the CPSU Central Committee L.I. Brezhnev emphasized the principled character of measures of the party aimed at reducing the gap in the levels of wages of rural and industrial workers. In the period from 1965 to 1978, the wages of workers of industrial enterprises in Kaluzhskaya Oblast grew 1.6-fold, of sovkhoz workers--2.2-fold and of kolkhoz farmers--2.7 fold. The rapid growth of the real income of rural workers is leading to a convergence of the levels of consumption of the city and the rural population. In this respect, the dynamics of availability of durable goods to city and rural families is characteristic.

Whereas in 1965 availability of television sets and refrigerators to the city population was 2-5 times greater than to rural inhabitants, today these indicators have drawn closer. In the beginning of 1979 there were 85 television

sets, 71 refrigerators and 81 washing machines per hundred families. In the city the figures were, respectively 9. television sets, 87 refrigerators and 71 washing machines.

On the Comprehensive Goal Program

The overcoming of differences between town and country does not consist of a mechanical leveling of generalizing or individual indicators of the development of industry and agriculture. Practical experience suggests the need for improvement of management, related processes and special comprehensive programs. In accordance with the principles of a comprehensive, systems approach to social phenomena and processes, town and country may be considered as complex social-economic systems. Each system breaks down into subsystems, which in their turn are subdivided into structural elements. The process of overcoming differences between town and country can be shown in a model consisting of dynamic series characterizing the development of structural elements. Providing a high level of development of agricultural production as the material basis of bringing closer together the working and living conditions of the urban and rural population, a comprehensive goal program ensures unity in the solution of production and social problems.

At the present time general plans have been compiled in republics and oblasts for the location of residential centers and their expansion. A considerable portion of the small and medium-size villages was found to have no future. We believe that differences in conditions in different areas of the country will not permit a stereotype solution to his problem. Of course, people will have to be gradually resettled from small, socalled nonpromising villages to central farm centers of kolkhozes and sovkhozes. But it would not be wise to force such a resettlement without taking into account concrete conditions. The fact is that small animal-husbandry farms, orchards, vegetable gardens and private farms of workers are to be found in the small villages. To remove these factors from the books would be perhaps too early. Today without a doubt it is necessary to permit the inhabitants of the small villages to live a full working and social life and to create for them necessary cultural-everday conditions. And here evidently an important role should be played by mobile means of trade and cultural-everyday services.

In a recently promulgated decree of the CPSU Central Committee and the USSR Council of Ministers on improving the economic mechanism, a number of important measures are provided for improving the planned management of social processes. Thus provision is made that there will be worked out in plans at all operational levels consolidated sections for the entire complex of measures in the field of social development.

In a number of the country's regions experience has been accumulated on modernization of large and medium-size villages according to the designs of rayon planning. In our view, it would be useful to expand the experiment to oblast size. The comprehensive goal program of modernization of agriculture must provide for the location of production, housing and cultural-everday facilities and for the development of the infrastructure. Verification of new forms of settlement on an oblast scale will make it possible to show at a higher level the rational principles of a practical solution of problems of overcoming differences in the way of life of the urban and the rural population.

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ECONOMIC EFFICIENCY OF NEW EQUIPMENT DISCUSSED

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[Article by B. M. Rabinovich: "On Evaluating the Economic Efficiency of New Equipment"]

[Text] The article is devoted to an evaluation of the economic effect of new equipment which is used in the sphere of surveying mineral raw materials resources. From the point of view of production "technology," the latter represents a series of continuous measurements of stocks of minerals. Measurement errors lead to economic damage for mining enterprises which is looked upon as a deviation in the values of technical and economic indicators from their optimal magnitude. It is demonstrated that an increase in the accuracy of the measurement of geological parameters provides the basic mass of the effect from the use of new equipment. A formula for calculating the integral effect of new geological surveying equipment is cited.

An increase in the efficiency of social production, including the efficiency of the use of new equipment, presupposes the disclosure and analysis of the factors which influence the relationship between result and expenditures. To this day the uncertainty factor continues to be the least studied of these factors.

One of the sources for the existence of this factor is errors in the estimates of the geological parameters which are determined in surveying stocks of minerals. And while in the branches of material production, chiefly in the mining industry, uncertainty takes on the character of consequences, in geological surveying work it is immanent in the production process and, consequently, directly influences its efficiency.

An evaluation of the economic efficiency of geological surveying work and of new surveying equipment is made difficult by the diversity of approaches to the definition of their basic categories--final product, and the economic efficiency criterion. The limited nature of many solutions in this

area is explained to a certain extent by an illegitimate abstracting from an evaluation of the consequences of the consumption of the final product of geological surveying work by the mining industry. For this reason, only by establishing a definite idea of the essence of the basic concepts of geological surveying work is it possible to correctly determine the economic efficiency of new equipment for surveying stocks of minerals.

Proceeding from a necessity for satisfying the economy's needs for mineral raw materials resources, geological surveying work is correctly regarded as a kind of infrastructure whose functioning ensures the production of stocks of minerals for the normal operation of the mining industry.

Geological surveying work consists of a number of successive stages. In those cases when after the performance of the initial stage stocks prove to be localized in the form of a promising deposit, surveying work in its subsequent stages is aimed at determining the values of the basic geological parameters by means of measuring them with the appropriate methods. The complexity which is characteristic of geological objects (the variability of geological characteristics in space) gives rise to the inevitability of errors in determining geological parameters; that is, a degree of uncertainty which accompanies the processes of prospecting and surveying which is not eliminated until the completion of work on the stocks. Hence, from the point of view of the "technology" of the realization of the final goal--an increase in mineral stocks,--geological work can be interpreted as a number of successive stages of reducing the size of the basic errors in the measurements of stocks. In accordance with this, the final results of the individual stages as a whole coincide in essence, differing only in the order of the accuracy of the measurements of stocks and in the degree of uncertainty.

The stocks of minerals which are included in planned or actual economic turnover figure in it in a cost evaluation which is equal to annual or to capitalized differential mining rent. Inaccuracies in geological information about the quantity and quality of stocks are the reason for inevitable errors in the economic evaluation of deposits. These errors become in the final analysis economically damaging to mining enterprises. Changes in the amounts of possible economic losses as a result of the performance of related stages of geological surveying work depend upon the extent to which a measurement of stocks is increased in accuracy and are an economic evaluation of the amount of risk with which the mine operators begin the extraction of minerals.

Thus, let us regard stocks of minerals in a cost evaluation measured with one or another degree of error to be the final result, the "product" of geological surveying work.

The distinctive characteristic of this "product" consists in the fact that in relation to geological surveying work it is a given substance, for stocks of minerals are given as a product of nature and a product of

socialist production relations. For this reason, the amount of the physical and economic parameters of the stocks does not depend upon the amount and level of expenditures for surveying. The latter, on the contrary, are derivatives of the above parameters which receive a concentrated expression in the level of the economic evaluation of deposits. But the given known correlation between the expenditures for forthcoming geological surveying work and the capital rent evaluation of deposits ($K \leqslant V$) requires concretization.

Since the economic evaluation of stocks is determined with inevitable errors which comprise the material content of the economic damage to mining enterprises, the amount of the expenditures for geological surveying work prove to be a consequence not so much of the amount of the rent evaluation of the deposits as, above all, of the level of damage, and serve as a means of bringing it to a permissible level. More precisely, the above-cited inequality is true if by an economic evaluation of stocks we have in mind not an estimated but a true (with regard to errors) value.

In other words, geological surveying work serves as a means of reducing economic damage to mining enterprises. The extent of this reduction is in fact the unique economic effect of geological surveying work. The relationship of this effect to surveying expenditures, compared to the normed capital investment efficiency coefficient, will characterize the actual level of the economic efficiency of geological surveying work.

However, what is economic damage? From the point of view of the established empirical ideas which appeal to possible inaccuracies in any information, economic damage is understood as any deviation at all in the actual values of the technical and economic indicators of working deposits from their supposed (planned) magnitute. In reality, proceeding from the theory of the optimization of planning and designing decisions, economic damage is a deviation in the actual (true) values of technical and economic indicators from their optimal magnitude. Errors in measurements of stocks of minerals are the basic factor in these deviations in the mining industry. Consequently, optimizing indicators have to reflect the influence of this deviation factor, which makes it possible to establish the degree of their stability and their reliability of the conclusions which are drawn on their basis.

The demand for a thorough study of deposits, "a study of our ore storeroom to its fine points" is a natural reaction by mining enterprises to errors in the measurements of mineral stocks and to their negative consequences.[1] Such demands which are based on the obvious result of daily practice are supported in argument, as a rule, by the high expenditure intensiveness of extracting minerals. While legitimate for the early period of the development of mining, they are not, however, absolute at the current stage of the development of economics.

At the present time expenditures to increase mineral stocks have increased to an amount (as a result of a steady increase in the need for mineral resources and the natural limitations on them and a tendency towards a worsening of the conditions for the performance of geological surveying work) which in many cases is commensurate with the amount of expenditures to extract minerals from the earth. Under these circumstances, the complete elimination of the negative consequences of errors in measurements of mineral stocks in the mining industry is economically unrealistic. The task is to bring the economic damage to mining enterprises to a permissible level.

Thus, an evaluation of the economic efficiency of new surveying equipment can only be regarded as satisfactory when it reflects the influence of the uncertainty of evaluations of geological parameters on a change in the basic technical and economic indicators of the exploitation of deposits.

Let us in this connection examine the influence of mineral stock measurement errors on a decisive indicator of the mining industry--the productivity of a mining enterprise. We shall proceed here from the following propositions: 1) the mineral stocks calculation formula has a multiplication form, that is, $Q=\prod_{i=1}^{i=N} P_i$ (P_i -- the estimated geological parameter, $i =$ 1, ..., N); 2) the maximum relative error in the measurement of stocks is equal to $\delta_0 = \sum_{i=1}^{i=N} \delta_i$ (δ_i --the maximum relative error in determining "i" geological parameter)[2]; 3) the annual productivity of a mining enterprise is determined by $A=Q\cdot T^{-1}$, (T --the length of the working of stocks, years); 4) the true productivity of a mining enterprise is equal to $A=\bar{A}_{опт}(1+\delta_0)^{-1}$ ($\bar{A}_{опт}=\bar{Q}/T_{опт}$ --the estimated optimal annual productivity of a mining enterprise, $\bar{Q}$ --the estimated value of the mineral stocks, t).

It is obvious that the establishment of $\bar{A}_{опт}$ and, consequently, of the amount of economic damage is connected with the selection of a method of evaluating the optimal length of time for the exploitation of deposits.

With an assigned branch plan for the extraction of mineral raw materials within a fixed planned period $T_{опт}$ can be found as a result of the solution of a minimized local criterion:

$$S=\frac{QC}{T}\,\frac{(1+E)^T-1}{E(1+E)^T}+\frac{Qx}{T}\approx\frac{QC}{T}\cdot\frac{1-e^{-ET}}{E}+\frac{Qx}{T}, \qquad (1)$$

where C--is the total capitalized expenditures adduced for the year the working of the stock begins, rubles; x--is the capital intensiveness of the extraction of the minerals, rubles year/tons. Capital investments for construction are made once, in the year immediately preceding the

year that the use of the deposit begins. C--is the cost (without the renovation of mining equipment and other fixed capital), rubles/tons; Q.T-1--is the annual rate at which stocks are taken, tons; Q.T-1=const; E--is the discount rate; e--is the basis of the physical logarithms; $1, \ldots, \theta$ --is the fixed planning period, $1 \leq T \leq \theta$.

The amount of S depends upon T. The optimal rate for selecting stocks is achieved when T has a value at which the function (1) is minimal. Differentiating S for T and equating the first derivative to zero, we will receive the equation:

$$\frac{E\varkappa}{C} = e^{ET}(1 + ET) - 1$$

or

$$T = \frac{1}{E}\left[e^{ET}\left(1 + E\frac{\varkappa}{C}\right) - 1\right]. \qquad (2)$$

Consequently, the optimal period for the mining of stocks does not depend upon their size, but is determined solely by the relationship of the controllable variables $\frac{\varkappa}{C}$. By arranging a number of deposits which have been designated for use according to the increasing magnitude of the relationship $\frac{\varkappa}{C}\left(\frac{\varkappa_1}{C_1} < \frac{\varkappa_2}{C_2} < \frac{\varkappa_3}{C_3}\right)$, we shall establish the dates of the beginning of the mining of the deposits, that is, the optimal length $(T_1 < T_2 < T_3)$, which will ensure for each of them minimum expenditures S. In the extreme (exclusively formal) case of $\varkappa = 0$, the length of the mining of the stocks takes on a fixed value equal to $T = \frac{e^{ET}}{E} - 1 = \mathrm{const}$.

After establishing the optimal value of the annual productivity of a mining enterprise, let us determine the maximum absolute error (economic damage) of the indicator $\bar{A}_{opt}$, which is caused by the uncertainty in the stocks estimates — δ_Q:

$$\Delta A = \left| \frac{\bar{Q}}{T_{opt}} - \frac{\bar{Q}}{T_{opt}(1 + \delta_Q)} \right| = \bar{A}_{opt}\,[\delta_Q(1 + \delta_Q)^{-1}] \qquad (3)$$

The maximum relative error of the indicator $\bar{A}_{opt}$, which has been calculated on the basis of the dependency (3) leads to a result which is unexpected for practice: $\delta_A = \Delta A : \bar{A}_{opt}(1+\delta_Q)^{-1}\delta_Q$. The identity which has been obtained can serve as a useful orientation point for geologists in choosing the accuracy of measurements of estimated geological parameters.

At the same time, it should be noted that damage in the form of the maximum absolute error of the indicator $\tilde{A}_{\text{сет}}$ represents an intermediate form of economic damage. Fluctuations in annual productivity lead to deviations in effect and expenditures, and a change in the level of the correlation between them under the influence of inaccuracies in geological information is the final form of expression of economic losses in the mining industry.

From the theoretical point of view it is most consistent to take the amount of the rent evaluation of stocks as the criterion of the effect of the work of mining enterprises. The maximum absolute error in the annual rent evaluation of stocks is:

$$\Delta R = |\tilde{R} \cdot \tilde{A}_{\text{сет}} - R \cdot A|. \tag{4}$$

where $\tilde{R}$ --is the estimated value of mining rent, $\tilde{R} = Ц - (\tilde{C} + E_н \tilde{к})$ rubles/tons; R--is the true value of mining rent $R = Ц - (C + E_н к)$, rubles/tons, $Ц$ -- is the wholesale price of a mined mineral which is established at the level of contiguous expenditures and adopted as a directive (error-free) parameter, rubles/tons; $\tilde{C}$, $\tilde{к}$ --is the estimated value of the cost of and the specific capital investments for the mining of a mineral

$$\tilde{C} = b + \frac{aT_{\text{сет}}}{\tilde{Q}}, \text{ руб/т;} \quad \tilde{к} = d + \frac{nT_{\text{сет}}}{\tilde{Q}}, \text{ руб} \cdot \text{год/т;}$$

a, b, d, n--are the empirical coefficients which are determined by means, for example, of correlation calculations; C, к --is the true value of the cost of and the specific capital investments for mining a mineral;

$$C = b + \frac{aT_{\text{сет}}(1 + \delta_Q)}{\tilde{Q}};$$

$$к = d + \frac{nT_{\text{сет}}(1 + \delta_Q)}{\tilde{Q}};$$

$E_н$ --is the normative coefficient of the effectiveness of capital investments which is taken as a directive (error-free) parameter.

By placing the values $\tilde{R}$, R, $\tilde{A}_{\text{сет}}$ in the formula (4) and performing elementary transformations, we will obtain:

$$\Delta R = \frac{(Ц - b - E_н d)\tilde{A}_{\text{сет}}}{1 + \tau_Q},$$

or

$$\Delta R = \frac{z}{1 + \tau_Q}. \tag{5}$$

where $Z=(\text{Ц}-b-E_{н}d)\bar{A}_{свт}$; $\tau_{Q}=\frac{1}{\delta_{Q}}$ --is the maximum accuracy in the measurements of stocks.

Consequently, the size of the variable ΔR (with the assigned parameters $\text{Ц}, b, d, E_{н}$) depends above all upon the annual productivity of a mining enterprise. The invariability of the amount of economic damage in relation to conventionally permanent expenditures which seems paradoxical within the framework of our empirical ideas about damage is grounded in the non-linear dependency of specific expenditures upon the amount of production.

In fact, fluctuations in the productivity of a mining enterprise under the influence of errors in the measurements of stocks lead at the same time to synchronized fluctuations only in those components of specific expenditures which are proportional to the intensivity of the selection of stocks. This means that the structure of expenditures for the mining of mineral raw materials exercises an influence on the amount of losses ΔR.

The dependency (5) is important.

By using formula (5) it is always possible to select the kind of size in the variable τ_{Q}, and, consequently, the amount of economic losses ΔR, when the inequality $R>0$ is fulfilled (with the given value Z). It is not difficult to see that the realization of this condition is regulated by the positive values of the error δ_{Q}, consequently, ΔR, for with positive values it is all the more correct. At the same time it is clear that with $R\leqslant 0$ it is necessary to deliberately adopt $\delta_{Q}=0, \Delta R=0$.

Consequently, the limits which have been examined to a change in economic damage which is treated in terms of an adopted criterion of effectiveness can be interpreted as a permissible area of existence for the function of losses (5), which makes it possible to record it in the form of the limitation $\Delta R_{1}\geqslant 0$. The concrete dimensions of this inequality are determined by the amount of the current rent evaluation of future or presently worked deposits. The area of the limitation ΔR_{1} grows narrower as R grows smaller and, on the contrary, grows with the growth of R. In other words, the limitation $\Delta R_{1}\geqslant 0$ "stimulates" a contraction or expansion of the interval in the actual values of the maximum absolute errors in the result of observations.

The permissible area for a change in economic damage coincides, of course, with the area for the existence of economically permissible errors in the measurements of stocks of minerals which limits the "zone of uncertainty" by the values $\delta_{Q_{1}}\geqslant 0$. This "zone" expands as the permissible economic damage increases, that is, as the value of the economic evaluation of a deposit increases.

The dependency (5) can be presented in the form:

$$\tau_{Q_z} = \frac{1}{\rho} - 1, \qquad (6)$$

where τ_{Q_z} --is the absolute permissible accuracy in the measurements of stocks;

$$\rho = \frac{\Delta R_z}{Z} (1 \geqslant \rho \geqslant 0).$$

With $\rho=0,\ \tau_{Q_z}=\infty$ --by definition ΔR_z occurs at the "worst" deposits; with $\rho=1,\ \tau_{Q_z}=0$ --characterizes the situation before the performance of measurements. The intermediate values τ_{Q_z} make it possible to evaluate a tendency toward a change in the accuracy of measurements of stocks and, consequently, the amount of expenditures for surveying.

With the value of the economic damage in the form of the maximum absolute error in the annual rent evaluation in our possession, we can establish a change in its size which is caused by a change in the value of the error δ_Q, resulting from the performance of a certain future (following after the initial one) stage of geological surveying work. The economic effectiveness of this stage, as a rule, is insufficiently clear.

Let us assume that the duration of the stage of geological surveying work being evaluated is limited to a year, and that the annual rent evaluation of stocks does not change in time, that is, let us examine a static situation of evaluating the economic effects of surveying. In this case the estimated value of the annual rent evaluation of stocks which has been established at the initial and contiguous stages will differ only in the amount of the maximum absolute error, and this difference is exclusively a function of the greater accuracy of the measurements of stocks, that is, $R_{t-1}=R\pm\Delta R_{t-1},\ R_t=R\pm R_t(\Delta R_{t-1}>\Delta R_t)$. Hence, the process of reducing the maximum absolute error (annual economic damage) in the result of observations which is determined by the error in the measurements of stocks at the initial stage t-1 of the performance of surveying work to a certain economically permissible level attained at the stage t being evaluated is equivalent, in essence, to the formation of the annual effect of geological surveying work. Let us write this in the form of the following equation:

$$Э = \Delta R_{t-1} - \Delta R_t - S_t, \qquad (7)$$

where S_t --is the adduced expenditures for geological surveying work at t stage, rubles/year; ΔR_{t-1} --is the maximum absolute error in the annual rent evaluation of a deposit which is determined on the basis of the information of the initial stage t-1 rubles; ΔR_t --is the maximum absolute error in the annual rent evaluation of a deposit which is determined as a result of the performance of the geological surveying work of the stage t being evaluated, rubles.

It follows from the equation (7) that the performance of geological surveying work at stage t is economically expedient at $Э>0$; at $Э=0$ it is insufficiently clear; at $Э<0$ it is inefficient.

In addition, the attainment of the actual economic damage ΔR_t and of the limits of the critical area, that is, $\Delta R_t \leqslant \Delta R_2$, has to be made sure of each time. The fulfillment of this inequality signals the possibility of curtailing surveying work and (given the other technical and economic conditions) of putting a deposit into industrial exploitation.

If $\Delta R_{t-1} \leqslant \Delta R_2$ (with $\Delta R_2 > 0$), and also in the hypothetical case (with $\Delta R_{t-1} = 0$ and only for this reason $\Delta R_2 = 0$), then surveying work at stage t is not required, that is $S_t = 0$; if $\Delta R_{t-1} \neq 0$, but $\Delta R_{t-1} > \Delta R_2$ (with $\Delta R_2 \geqslant 0$), then the task of bringing ΔR_{t-1} to the permissible level ΔR_t ($\Delta R_{t-1} \geqslant \Delta R_t \leqslant \Delta R_2$) is placed upon the planned surveying work at stage t with the additional expenditures S_t. The latter achieved the upper limit $\Delta R_{t-1} = S_t$ with $\Delta R_t = \Delta R_2 = 0$ (since $R_{t-1} \leqslant 0$), changing in this way in the interval $\Delta R_{t-1} \geqslant S_t \geqslant 0$.

The above described propositions make it possible to perform an evaluation of the economic efficiency of new surveying equipment.

The publication of the Methodology for Determining the Economic Efficiency of the Use of New Equipment in the Economy[4] signifies an official status for a number of methodological propositions of the theory of efficiency which concern, in particular, the necessity for evaluating the consumer's effect. This effect is found from a solution of the equation of the equal effectiveness of adduced expenditures for the production of output by the consumer involving the use by him of base or of new equipment, an equation which reflects the demand for "identity of effect."

However, upon closer examination it turns out that the basic formulas for calculating annual economic effect which are recommended by the Methodology are not universal. They provide satisfactory results for branches in which a cost evaluation of output which is created with new equipment appears in the regularized (rational) form of price. But in those places where natural resources are the object of the application of equipment the formulas are correct only in an individual case. Geological surveying work belongs here.

Let it be given that there is a plot of earth which as a result of the performance of a certain basic amount of geological surveying work can be regarded as promising in stocks of minerals. In addition, the quality of the geological surveying work which is evaluated in this case by the size of the maximum absolute or relative error in the measurements of the stocks is such that the latter are an uncertain magnitude.

The planned surveying work has the goal of reducing the maximum relative error δ_0 from its initial value to a level at which there would be a guarantee of permissible limits to the mining enterprise's economic damage which is inevitable in the working of stocks.

Let us examine two variants of planned surveying work which differ in amounts of expenditures the difference in which is the result solely of adduced expenditures which are equal to the expenditures of the producer of the base and new equipment which is intended for measuring a certain estimated geological parameter; of the maximum relative errors in the measurement of the geological parameter by means of the base and the new equipment; and of the amount of the economic damage in the form of the maximum absolute error in determining the annual rent evaluation of the deposit. In addition, let us assume that the errors in the other (besides the measured one) geological parameters which go into the formula for the calculation of the stocks remain unchanged.

On the basis of the formula (7) (on condition that $\Delta R_{t-1} \neq 0,\ \Delta R_{t-1} > \Delta R_{A}$) and with regard to the premised assumptions, let us record the procedure for determining the annual economic effect of the surveying work for the surveying equipment variants in the form of the following equations:

$$\begin{aligned} Э^{б} &= \Delta R_{t-1} - \Delta R_t^{б} - S_t^{б} \\ Э^{н} &= \Delta R_{t-1} - \Delta R_t^{н} - S_t^{н}, \end{aligned} \qquad (8)$$

where $Э^{б}$, $Э^{н}$ --is the effect of the surveying work in the form of a decrease in damage with the use of the base and the new equipment, respectively, rubles/year; $\Delta R_t^{б}$, $\Delta R_t^{н}$ --is the maximum absolute error in the annual rent evaluation of the deposit determined on the basis of the performance of surveying work at stage t with the use of the base and new equipment, respectively, and calculated by formula (5), rubles; $\Delta R_t^{б} \geqslant \Delta R_t^{н} \leqslant \Delta R_{A}$
$\Delta R_t^{б} = \dfrac{Z}{1+\tau_Q^{б}}$; $\Delta R_t^{н} = \dfrac{Z}{1+\tau_Q^{н}}$; $S_t^{б}$, $S_t^{н}$ --is the adduced expenditures for the production of the base and new surveying equipment, respectively, ruble/year.

Using the equation (8) we determine the annual effect of the new geological surveying equipment in the following manner:

$$Э^{н.т} = Э^{н} - Э^{б} = (\Delta R_t^{б} - \Delta R_t^{н}) + (S_t^{б} - S_t^{н}). \qquad (9)$$

By placing the values $\Delta R_t^{б}$, $\Delta R_t^{н}$ in the formula (9), putting the second component (9) into a comparable form by virtue of the differences in the qualitative parameters of the base and new equipment, and ensuring the comparability of the different forms of effect in (9) for the time factor, we will obtain:

$$Э_{Σ}^{н.т} = \left[\frac{Z(\tau_Q^{н} - \tau_Q^{б})}{(1+\tau_Q^{н})(1+\tau_Q^{б})} \right] (P_2 + E_н)^{-1} + (S_t^{б} \alpha_1 \cdot \alpha_2 \cdot \alpha_3 - S_t^{н}). \qquad (10)$$

where $Э_{Σ}^{н.т}$ --is the annual effect of the new geological surveying equipment during its service life, rubles; $\alpha_1 = \dfrac{\delta_t^{б}}{\delta_t^{н}}$ --is the coefficient of the

equipment variants for the accuracy level of the measurements of i geological parameter; $\delta_i^б \geqslant \geqslant \delta_i^н \leqslant \delta_{i_д}$, $\delta_i^б$, $\delta_i^н$ --is the maximum relative error in the measurements of i geological parameter with the use of the base and the new equipment, respectively; $\delta_{i_д}$ --is the maximum relative permissible error in the measurements of i geological parameter; $a_2 = \frac{\beta_2}{\beta_1}$ --is the coefficient of the adduction of the equipment variants for production volume; β_1, β_2 --is the annual amount of surveying work performed in measuring i geological parameter with a unit of base and new equipment, respectively, in physical units; $a_3 = \frac{P_1 + E_н}{P_2 + E_н}$ --is the coefficient of the adduction of equipment variants for service life; P_1, P_2 --is the renovation norm for the base and the new equipment, respectively, calculated as an amount inverse to service life (or according to the formula $P = \frac{E}{(1+E)^{Tc-1}}$), including wear and tear.

With assigned $\Delta R_i^б, S_i^б$, the maximum effect (10) is achieved with a minimum amount of economic damage and of expenditures for surveying work in the new variants. But this task is contradictory, for a decrease in $\Delta R_i^б$ is unfailingly connected with an increase in the accuracy of the measurements of stocks, that is, with an increase in the coefficient α_1. The latter is connected, as a rule, with an increase in the expenditures $S_i^н$.

Consequently, using the terminology of the Methodology, the effect of new equipment determined by formula (10) is also composed of the effects of the "producer" and "consumer." However, strictly speaking, the existence of the latter is only possible with $\alpha_1 > 1$. An improvement of any other qualitative parameters of the equipment does not affect the size of the "consumer's" effect.

In the individual case when $\alpha_1 = 1$, but the new equipment is more productive and longer lasting than the base equipment, formula (10) takes on a form which is standard for the branches of material production:

$$Э_2^{н.т} = (S_i^б a_2 \cdot a_3 - S_i^н). \qquad (11)$$

It follows from formula (10) that the effect of increasing the accuracy of measurements of stocks substantially increases the effect of new surveying equipment in the sphere of its direct application. This means that when base equipment is replaced by new equipment even a negligible increase in the accuracy of measurements yields a palpable economic effect. The distinguishing of this effect in selecting surveying equipment variants ensures a correct economic orientation by designers and producers when they improve qualitative parameters.

At the same time, it is obvious that since with a given annual productivity by a mining enterprise and a given increase in the accuracy of new equipment over base equipment the effect in the form of reducing economic damage is greater at "better" deposits than at "worse ones," the basic mass of new equipment (given its limited nature) should be concentrated above all at deposits which have a higher economic evaluation.

Thus, let us establish the following special features of evaluating the economic effect of new geological surveying equipment.

1. The basic mass of the effect is made up of a decrease in the amount of economic damage in the sphere of mining minerals with the use of new and more accurate equipment instead of base equipment for measuring geological parameters.

2. The "consumer's" (mining industry) effect does not depend upon the mass and productivity of geological surveying equipment.

3. A calculation of effect is connected with determining the permissible errors in measuring stocks and their cost equivalent.

The practical realization of the proposed methodology presupposes above all a permanent (at every stage of geological surveying work) economic evaluation of mineral stocks.

FOOTNOTES

1. PRAVDA 27 January 1978.

2. The maximum absolute error is understood as the smallest positive number, larger than or equal to the modulus of the exact error, which cannot exceed the error of the measurements. The maximum relative error is the relationship of the maximum absolute error to the true value of the magnitude being measured. (See B. N. Shchigolev, "The Mathematical Treatment of Observations," Moscow, Fizmatgiz, 1962). Practice makes frequent use of statistical errors. The connection between maximum and corresponding statistical errors which evaluate (with an assigned probability) the existence of the result of observations within the limits of the interval of its fluctuation can be realized on the basis of the use, for example, of the well-known rule of three sigmas. Making the distribution of the magnitude being measured subordinate to the normal law, the value of the maximum error which goes beyond the limits of the three sigma range is fixed (with a certain maximum probability). The correlation between the calculated maximum error and the standard (average squared) deviation is fixed at this point.

3. It is permissible to liken the maximum permissible errors in determining effect to allowances in equipment which are rigid limitations whose violation with certain product parameters leads to a rejection of output.

4. EKONOMICHESKAYA GAZETA, No. 10, 1977.

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DEVELOPMENT OF TOOLS OF LABOR DURING SCIENTIFIC, TECHNICAL REVOLUTION

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/Article by D. M. Palterovich: "Peculiarities of the Development of the Tools of Labor During the Period of the Scientific and Technical Revolution"/

/Text/ The current trends in the development of the tools of labor, new spheres of the use of machinery, the main directions in the development of equipment and the need to convert to sectorial and functional machine systems are examined. The most important directions of the structural shifts in the production of tools of labor and the peculiarities of the reproduction of the equipment park are shown.

Under the conditions of a developed socialist economy, as the scientific and technical revolution develops, changes accumulate in all the functional components of the material and technical base. Especially significant changes are occurring in the active component of the fixed capital--the tools of labor. The well-known assertion of K. Marx that "economic ages are differentiated not by what is produced, but by how it is produced, by what means of labor"[1] applies above all precisely to them.

Radical changes are occurring in the composition and structure of the tools of labor, in their technical level, the quality and scale of production, in the nature of the reproduction and use of the operating park. One of the important tasks of economics is to reveal in detail the content of these changes, to identify the directions of scientific and technical progress, which express the essence of the scientific and technical reovlution, to determine the shifts in the sectorial, technological, type size and age structure of the equipment and to discover the tendency toward the increase of the role of tools of labor in the development of all the sectors of the economy and in meeting the rapidly changing social demands. The analysis of the development of tools of labor in the indicated directions is a necessary condition of the implementation of an effective state technical policy.

The most important changes in the tools of labor at the present stage of development can, in our opinion, be reduced to the following. First, the sphere of use of modern tools of labor both within physical production and outside it is increasing intensively. Second, the processes of developing and introducing fundamentally new equipment and technology are being expedited, a park of equipment of a new type, which makes it possible to change both the means of affecting the object of labor and the ratio of mechanized and manual labor and the nature of the interaction of man and machine, is gradually forming. Third, the shift from the use of individual machines and devices to systems and sets of machines, which embrace all the stages and technical operations of the production of products and services, is being carried out. Fourth, the process of reproducing the equipment pack is being expedited, which is reflected in the amortization policy of the state and in the distribution of resources of new equipment for the needs of the expansion and updating of the park. Fifth, a number of new factors are appearing, which influence in different directions the degree of utilization of the equipment park and the machine output, in connection with which the increase of the efficiency of the tools of labor is becoming a specific object of planning and management.

Increase of the Sphere of Use of Machines. Under present conditions the increase of the sphere of use of machines is taking place first of all in physical production itself, and in several directions. Thus, auxiliary and several other operations, which previously were performed mainly by hand: the placement of the object of labor in the work zone, the positioning of parts on the machine tool, changes of position between operations, assembly, technical control, information processing and others, are being mechanized.

Further, mechanized equipment is being introduced more and more extensively in the sectors of the production of services--trade, public dining, personal services. For example, modern trade in practice cannot develop without a large number of special transportation and materials-handling equipment, refrigeration equipment, automatic scales which determine simultaneously the weight and cost of an item, bagging, packing, check-out and other equipment, a shortage of which causes excessively great expenditures of labor, losses of goods and a decrease of the quality of service.

The list of equipment at the organizations and enterprises of the personal services system is very large. Here some types of equipment are manufactured specifically for the sectors of this sphere (equipment for barbershops and hairdresser shops, laundries, dry cleaning, the repair of radios and electrical appliances), others still have to be borrowed mainly from the sectors of industry (sewing, knitwear, shoemaking, wood working and metalworking, construction equipment).

The extensive penetration of mechanical equipment in all sectors of the nonproductive sphere is one of the most important manifestations of the scientific and technical revolution. The increase of the demands which are being made on the sectors of this sphere dictates the need to use in them

complicated and diverse equipment, without which public health, education, science, culture and management under present conditions could not fully perform their functions.

In medicine, for example, the most complex electronic equipment: automatic systems of diagnostics and the monitoring of the condition of patients or analysis equipment for the simultaneous performance of a set of tests, is being used more and more extensively. The production of medical equipment is becoming one of the most dynamic sectors of machine building. During the Ninth Five-Year Plan alone this sector put into production about 600 new models of machines, devices, equipment and instruments. The output of the sector from 1965 to 1975 increased 2.2-fold, and during the 10th Five-Year Plan the output of the medical industry will increase by 44-46 percent.[2] However, the demand for modern medical equipment is still increasing more rapidly than its production, in connection with which the further development of the enterprises of this sector, as well as the increase of the production of medical equipment in other sectors, especially in the electronics industry, remain an urgent problem of machine building.

More and more equipment is being used in the educational system: equipment for audio and video recording and playback, training simulators, trainers, laboratory and other instruments, computers, machines for programmed instruction and others.

The spheres of management, finance and accounting in practice can no longer exist without numerous and diverse computer hardware, duplicating equipment, special communications equipment and office equipment. During the Ninth Five-Year Plan the output of computer hardware increased 4.3-fold. The sector for the production of office equipment increased the production of means for mechanizing and automating engineering and administrative labor 1.9-fold, but the demand for them is being met far from completely, especial for means for compiling, storing and retrieving documents.

The demand for scientific equipment, which is notable for an enormous diversity and constituted, according to the data of the census of fixed capital on 1 January 1972, more than 40 percent of the fixed capital of science, is increasing exceptionally rapidly.

On the whole approximately 25 percent of the workers, employees and kolkhoz farmer are employed in the sectors of the nonproductive sphere, but less than 4 percent of the value of the active component of the fixed capital of the national economy (excluding available housing) falls to them. Of course, it would be incorrect to require an identical machine-worker ratio in sectors with a different nature of activity. However, the fact that in the nonproductive sphere the active capital-labor ratio, according to our calculations, in 1972 was on the average one-sixth (and excluding science one-thirtieth) as great as in the nonproductive sphere, is connected, it seems to us, with the fact that the equipment of the nonproductive sphere owing to the special nature of its activity was begun comparatively recently and was developed at an inadequate rate. Advanced domestic and foreign

experience attests that a high level of technical equipment of the sectors of the nonproductive sphere is becoming a necessary condition for their efficient operation, the saving of labor in these sectors and the increase of the level of management and the quality of service. All this determines the need for further structural shifts in machine building in the direction of the accelerated development of the sectors which produce equipment for public health, education, science and management.

The next direction of the increase of the sphere of use of machines and equipment during the period of the scientific and technical revolution involves the emergence of such new demands as the development of space and the resources of the ocean, environmental protection and others. New major machine building enterprises for the production of equipment for the purification of water and air, for the utilization of domestic waste and others are being built.

In order to characterize the scale of the use of equipment in these new spheres it is possible to cite the fact that during the 10th Five-Year Plan state capital investments in the amount of 11 billion rubles (with allowance for the capital of enterprises and organizations more than twofold more) have been allocated for environmental protection measures.[3] The cost of purification, recovery and other equipment, which in many cases makes it possible not only to avoid the pollution of the water and air, but also to utilize production wastes, constitutes a considerable share of them. Thus, in the construction materials industry more than 5,000 dust removers have been built, by means of which more than 20 million tons of various products worth in excess of 120 million rubles are being recovered and utilized.

The increase of the area of use of the tools of labor is also taking place by means of the development of the household sphere and the private subsidiary farms of kolkhoz farmers. A high saturation with various types of equipment is also typical of modern housekeeping. According to the data of Edison Institute, 166 different electrical applicances can be used to make housework easier.[4] Moreover, according to the data of specialists, one-third of the items for cultural and everyday purposes and household use become obsolete annually, while half as many are updated.[5]

The retention under the conditions of the developed socialist economy of the private subsidiary farms of kolkhoz farmers and the development of dacha and gardening cooperatives are facing the production of the tools of labor with another task--to technically equip the labor in these sectors and to make it easier and more productive. Obviously, the large-scale production of garden and orchard tractors with a rating of 5-10 hp and sets of implements for them, which ensure the mechanization of all the work on the private and orchard plots, should be organized in the immediate future.[6]

The increase of the sphere of use of the tools of labor is leading to profound shifts in the structure of machine building. In particular, the follow calculations, which were made according to the data on the gross production of 67 economic sectors and subsectors of machine building and

metalworking, which produce and repair the main types of machines and equipment for the national economy, attest to these structural shifts. During the period from 1966 to 1977 the proportion of the sectors producing equipment for power engineering and electrification in the above-indicated group decreased from 16.8 to 14.6 percent, for the sectors of the processing industry--from 11.7 to 10.3 percent, for the extractive industry--from 3.5 to 2.9 percent. At the same time, the proportion of the sectors producing equipment for general production purposes increased from 14.4 to 15.3 percent, and machines for the nonproductive sphere and services--from 2.3 to 5.7 percent, that is, 2.5-fold.

Important changes are also occuring in the ratio of the production of fundamentally new and traditional equipment. The production of such types of equipment as electronics, aerospace and nuclear equipment, instruments and automation equipment, while being developed at an anticipatory rate, is becoming comparable in its scale to the production of traditional types of equipment.

Finally, owing to the increase of the social demands on equipement, there is taking place, on the one hand, a rapid growth in the production of equipment which is specifically intended for solving social problems and improving the conditions of work and everyday life, and, on the other, an improvement in the ergonomic and esthetic characteristics of traditional equipment. All this affects the sectorial and technological structure of the production of machine building.

The Development and Introduction of Fundamentally New Equipment. Modern scientific and technical progress in the area of the tools of labor can be classified according to the following directions.

1. Automation in its traditional forms (automatic reflex machines and automatic lines) and in fundamentally new forms, including the development of automated control systems, sets of equipment with programmed control, the automation of designing and the engineering preparation of production.

2. The development of equipment for the use of fundamentally new means of affecting the object of labor. Among these means it is necessary to distinguish first of all the nonmechanical means: atomic, chemical, electrochemical, electrophysical (including electron-beam, electric-spark, electroerosion, radiation and others), as well as some mechanical means: magnetic, explosive, vibration, pneumatic and hydraulic.

3. The increase of the unit capacity and productivity of machines, units and apparatus, which is accomplished by various means: the increase of their dimensions, the increase of the speed, the throughput, the temperature, the pressure and so forth.

4. The conversion from discrete to continuous processes on the basis of the use of a new processing method and complete mechanization, including the use of systems and sets of machines, the mechanization and automation of changes

of position between operation, auxiliary operations and the elimination of periodically arising malfunctions.

The first two directions--automation and the use of fundamentally new means of affecting the object of labor, especially in those cases when their combination is ensured--change the production technology the most radically. The continuity of the processes and the increase of the unit productivity of the integrated sets of machinery are most often achieved also on the basis of or by means of automation and the latest processing method.

The assertions of a number of economists (M. A. Vilenskiy, V. I. Kushlin, G. D. Danilin) that automation, which does not change the principles of the technology of processing materials, is of limited significance, does not ensure qualitative improvements in the productive forces and does not reflect the essence of the scientific and technical revolution,[7] in our opinion, are unsound for a number of reasons.

First, the concept of technology is not limited only to the means of acting on the material being processed. It also includes the method of changing the position of the object of labor during the processing, the sequence of operations, the nature of the material, the tool, the conditions of processing and so forth. Automation has a decisive influence on all these components of the processing method, determining thereby the production efficiency.

Second, automation encompasses not only the processes of processing, but literally all the aspects of production, starting with the designing and ending with a number of functions of the management of enterprises and sectors.

Third, automation according to the themes and scale considerably surpasses the introduction of equipment for fundamentally new technological means of processing. Thus, in USSR machine building the balance sheet value of automatic lines is more than 11 percent of the value of operating machines and equipment, while the value of machine tools for electrochemical and electrophysical treatment is a fraction of a percent. According to the data of the census of metalworking equipment of 1972, in the national economy the proportion of automatic and semi-automatic machine tools of all types was in number 5.6 percent, but in value about 16 percent, while the proportion of electric-spark, electrochemical and ultrasonic machine tools in number and value was respectively 0.4 and 0.9 percent. Here the latest achievements in the area of automation are affording truly unlimited opportunities for the transformation of the equipment, technology and organization of machine building production, since the sphere of the economically efficient use of electrophysical and electrochemical methods is increasing considerably more slowly than was predicted in connection with a number of technical difficulties.

Finally, fourth, it is automation which has a decisive influence on the nature and conditions of labor, precisely it plays the main role in transforming workers of physical labor into managers of production processes.

Of the main directions of automation the automation of technological processes remains the main one. And along with the quantitative and qualitative increase of the park of traditional automation equipment the production of new types of it is being developed at an anticipatory rate. The park of equipment with numerical programmed control in industry reached at the end of 1978 about 55,000 units,[8] including, according to our approximation, about 40,000 units of machine tools. The link up of these machine tools, especially multiple-operation machine tools, with a control computer and automatic manipulators (robots) paves the way for the development of multi-product automatic sections and shops, which are capable of being rearranged according to a set program. The first sections made up of computer-controlled machine tools with numerical programmed control, which have been set up in our country, ensure an increase of labor productivity by 3- to 5-fold. Their futher development, the increase of the technological potentials, the conversion to computer programming and the development of systems of adaptive control (which are self-adjusting, self-instructing and select the optimum operating conditions) will lead in the future to the development of a production technology of a fundamentally new type--the completely automated technology not only of mass production, but also of series and custom production.

Automated control systems of technological processes (ASUTP's) are being introduced more and more extensively in metallurgy, the chemical industry, petroleum refining and other sectors. During 1966-1978 1,324 ASUTP's were set up in the country, many of which are operating very efficiently. For example, at the Western Siberian Metallurgical Combine a completely automated, computer-controlled rolling mill capable of producing a wide range of items has been started up. In all 20 operators keep track of the operation of all the sections of the mill.

However, it should not be assumed that a developed socialist economy can and should be based entirely on the highest forms of automation. It would be a mistake, for example, to assert that machine tools and sections with programmed control in the foreseeable future will supplant equipment of other types in machine building. In mass and large-series production the productivity of semi-automatic multispindle standard-unit machine tools is tens of times greater than machine tools with numerical programmed control (including multi-operation machine tools like the "machining center"). The equipment which is equal to the demands of a developed socialist economy will always be characterized by a great diversity and the combination of simple and complicated, traditional and the latest forms, which are chosen with allowance for the nature and conditions of production.

It should be emphasized that the processes of automation and the introduction of fundamentally new technology most often are directly interconnected. The electrochemical, electron beam (laser), plasma, pneumatic and other nontraditional methods of affecting technologically the object of labor are usually distinguished by a higher level of continuity and convenience of regulation and therefore lend themselves more easily to automation. At the same time the mentioned technological processes are usually carried out

under the conditions of high speeds, temperatures and other harmful effects and therefore are practically impossible without automation.

The fundamentally new processing methods have extensive prospects for use in many sectors: in the shaping of metal and other construction materials by means of electrochemical, ultrasonic and laser exposure; the drilling or crushing of rock by the methods of liquefaction or burning; the accomplishment of high-speed chemical reactions using electricity or plasma; the improvement of the properties of materials and products under the influence of radiative, ultraviolet or other irradiation; for the formation of thread or fabrics using pneumatic or hydraulic influence and so on. The use of these methods yields in a number of cases a multiple increase of the productivity in combination with an improvement of the quality of items. However, the optimistic predictions of the relatively rapid increase of the sphere of effective use of electrophysical and electrochemical methods in many instances did not prove to be correct due to their inadequate productivity or for other reasons. Machine building should, in our opinion, launch research and development more extensively to surmount the unusual technical barrier which has arisen in the way of the dissemination of the nonmechanical technology of processing materials.

The achievements in the area of developing microcomputers have made possible the automation not only of stationary, but also mobile equipment: the motor vehicle, the tractor, the washing machine: inexpensive microprocessors made with large integrated circuits will perform various functions of control, including the optimization of operating conditions, fuel consumption and so forth. According to the data of specialists, in the foreseeable future microprocessors may be used in more than 200,000 different devices and units of production and household equipment.[9] This, no doubt, is a qualitative jump in the development of the scientific and technical revolution.

Automated control systems of enterprises, associations and sectors are important components of automation. During 1966-1978 1,431 such automated control systems, as well as 176 automated data processing systems were set up in the USSR. They save the labor of many thousands of accounting and administrative workers.

The quite recently begun automation of planning and design work and the engineering preparation of production promises a great socio-economic impact. Calculations, the drawing up of standard documents and other operations, which computers can perform, take up the bulk of the time for accomplishing them. The automated system of planning of technological processes, which has been developed in our country, decreases the labor-intensiveness and the period of planning of the machining of the simplest parts to one-half to one-fifth, parts of average complexity to one-fifth to one twenty-fifth and complicated parts to one twenty-fifth to one one-hundredth. Here the production cost of items is reduced by 20-30 percent by means of the acceleration of planning and the increase of the technological feasibility,[10] the flexibility of production when placing new items into production increases.

Perhaps no one direction of scientific and technical progress depends on the forms of the organization and management of production to the extent that automation does. The slow introduction in production of some types of automatic equipment, their poor utilization and the inadequate effectiveness of many measures on automation[11] to a great extent are explained by the substantial shortcomings in the area of the specialization and concentration of production. The full-fledged utilization of modern highly productive equipment, as is known, requires the organization of highly specialized production which is large-scale not in the number of workers and diversified shops, but in the output of technologically similar products. The decrease of the cost of automation equipment is also of great importance.

Thus, although automation is one of the most important principles of the technical development of production under the conditions of a developed socialist economy, its efficiency is not achieved automatically: it requires the improvement of the entire economic mechanism and the achievement of an adequate level of the organization and management of production.

The Conversion to the Use of Machine Systems. The intensification of mechanization, its coverage not only of basic, but also of auxiliary processes at all stages of production, and the use of automatic equipment to increase its continuity created the prerequisites for the conversion from individual machines to sets of machines, which perform the entire cycle of operations on the production of a product or on the completion of major final stages of such production. The next step is the combination of the sets into machine systems, which are designed for the mechanization and automation of all the production processes in the given sector (sectorial systems) or for the performance of similar functions in all sectors (functional systems).

The conversion to the development and use of sets and systems of machines under the conditions of the developed socialist economy is becoming an objective necessity. Without it it is practically impossible to ensure the dynamic and proportionate development of production. The more developed the economy is and the more extensively the achievements of the scientific and technical revolution are utilized in it, the closer the interaction and interdependence of all its components are. The complication of the processing method and its breakdown into a large number of independent stages, which are performed by different machines and devices, increase the importance of the interdependence and complementariness of technological equipment to the extent that only the development of sets of equipment, which encompass all the production stages and operations, ensures the continuity of the processes, the efficient use of the means of production and the rapid increase of labor productivity. The conversion to the development and use of machine systems will make it possible to eliminate the "gaps" in the chain of mechanization, to make it comprehensive, to ensure the congruence of all the links of the technological chain of machines in capacity and productivity and to eliminate the disproportions in the number and capacity of technologically associated types of equipment.

The development of machine systems for all the sectors of the production and nonproductive spheres will be the basis for the drafting of programs of their reequipment. For the sectorial machine system as the aggregate of the technological sets of equipment, which ensure the production of the finished product or the performance of the final major stages of the processing method, should be formed on the basis of advanced scientific and technical achievements. Such a system, of course, will include not only the equipment being produced, but also the designs and engineering assignments, which should be realized when developing new equipment. In this sense the machine system should contain programs of actions for the sector for which it is being developed, for the sectors which produce the appropriate equipment and for those who are drawing up the designs.

In order to solve the enumerated problems it is not enough only to develop machine systems for all the sectors of physical and nonphysical production, it is necessary to make these systems the basis of planning of the processes of the development, production and introduction of new equipment. Without a change in the planning procedure the machine systems might be ineffective.

Let us illustrate this situation with the following example. When developing individual machines and devices disproportions often arise between the power and operating machines, as a result the potentials of the power units are not fully utilized. Thus, about half of the potentials of the new power-packed Kirovets tractors were utilized due to the lack of the appropriate operating machines. Meanwhile, the Ministry of Tractor and Agricultural Machine Bulding back before the start of the production of Kirovets tractors developed a machine system for the complete mechanization of agricultural production. However, at that time this first machine system in the country had not yet become the basis of planning of the development and production of new equipment.

In this connection every machine system should, in our opinion, be supplemented with a comprehensive program which provides for the simultaneous organization of the development and production of all the descriptions of equipment for any set included in the system.

In practice every sector needs instruments, automation equipment, office equipment, materials-handling, warehouse and packing equipment. When developing sectorial machine systems these types of equipment should be borrowed from functional systems. This will ensure a high technical level, the standardization of equipment, the reduction of its cost in connection with the increase of the series nature of production and the improvement of the organization of repair work.

Among the machine systems developed in our country the systems for the complete mechanization of agricultural and construction work are distinguished by their completeness and degree of development. The main principles of the formation of these systems, particularly those such as the promising nature, the stage-by-stage introduction, the use of advanced achievements of domestic and foreign technology, the complete coverage of the production

process of the sectors and others, can be used when developing other machine systems. However, for most sectors machine systems have not yet been developed, the developed ones have not been supplemented by comprehensive programs of their implementation and are being introduced too slowly into production. Obviously, it would be useful to have an officially approved list of machine systems with an indication of the dates of their development and the responsible performers.

Peculiarities of the Reproduction of the Equipment Park and Amortization Policy. The scientific and technical revolution, as is known, is accelerating the process of reproducing the equipment park and shortening its service life. However, this is only the overall trend. The specific influence of scientific and technical progress on the rates of wear and obsolescence of the means of labor is contradictory. The wear of machines, on the one hand, is being slowed as a result of the use of stronger materials, the increase of the reliability and durability of the designs and the improvement of the system of preventive maintenance and servicing, and, on the other, is being accelerated as a consequence of the increase of the intensity of the use of equipment, especially expensive automatic equipment, as well as the increase of the severity of its operating conditions.

Under the conditions of a developed economy the importance of wear of the second type is increasing.[12] Means of labor, which are temporarily idle for a number of reasons, often break down too rapidly due to the lack of the proper conditions of storage, corrosion proofing and upkeep. This especially influences the rate of wear of the enormous park of agricultural and construction machinery, which is operated and frequently also stored in the open.

The influence of technical progress on the obsolescence of means of labor is displayed primarily in its acceleration. This pertains especially to the second form of obsolescence, which is connected with the appearance of new, more productive models of machinery. However, the danger of illusory, or apparent, obsolescence arises here.

Le. us explain in more detail. The placement of a new model of a machine into production gives rise to the need to replace the old machine in the pa:k only if the impact of the introduction of the new model is sufficient not only to recover the expenditures on the new machine, but also to compensate for the underamortized value of the old machine. Thus, if the equipment is replaced before the end of the standard service life, greater demands should be made on the efficiency of the new means of labor.

The realization of the above-examined directions of scientific and technical rogress periodically leads to the development of fundamentally new, more productive equipment which meets the indicated requirements. At the same time it is well known that a significant portion of the machine models developed in recent years are characterized by a sharp price increase as compared with previous models, and the increase of the prices considerably exceeds the increase of their productivity. Moreover, the increased productivity indicated in the technical certificate is often specified for some ideal

conditions which in practice are not realized in the sphere of use of the machines. In other words, the estimates of the productivity of the new equipment, which substantiate the feasibility of replacing the old models with it and thereby determine the obsolescence of these models, often do not prove correct in practice. As a result, the obsolescence of the old models of machines is apparent.

The calculations made using economic-mathematical models on the basis of the example of machine tools and textile machinery showed that obsolescence of the second form sets in only if the new design called upon to replace the old design exceeds it considerably (by 1.5-2 times or more) in productivity.[13] In this case even the outstripping increase in prices has little influence on the decrease of the efficiency of the new machine. If the increase of the certified productivity of a new model is negligible (10-20 percent), its appearance does not promote the acceleration of obsolescence. The effective service life of the old model in this case is not shortened, but even increases.[14]

Hence follows an important conclusion: it is expedient to replace old machines by new ones in production somewhat less frequently, increasing thereby the possibility of the "maturation" and assimilation of machines which are based on new technical principles that make it possible to increase significantly their productivity and efficiency. At the same time during the period of the scientific and technical revolution the process of developing fundamentally new equipment is intensifying.

The service life and rate of replacement of the operating park of machines depend not only on obsolescence which is connected with the date of appearance and the increase of the productivity of the new models, that is, not only on technical progress, but also on the balance of new equipment and the distribution of its reserves for the needs of the replacement and expansion of the park. The increase of the scale of production of the means of production under the conditions of a developed socialist economy provides a potential opportunity to allocate for the replacement of the park a larger and larger proportion of the reserves of equipment, shortening in this case both the standard and the actual service life of the machines. At the same time the rapid increase of the scale of the operating production equipment under the conditions of the limitation of manpower resources is making it necessary to shift from the extensive expansion to the intensive development of the equipment park and to the acceleration of its replacement with a sharp restriction of quantitative growth. This is seen especially clearly from the example of the park of metalworking equipment.

For a long period the bulk (70-80 percent) of the reserves of metalworking equipment were allocated for the expansion of the park. As a result the park of machine tools increased from 2.2 million units in 1962 to 4.5 million in 1974. The park of forge and press equipment increased from 468,000 in 1962 to 1,018,000 in 1974.[15] However, the increase in the number of machine tool operators lagged behind the growth of the park, which was one of the main reasons for the worsening of the use of the equipment.

It is easy to calculate that if the increase of the size of the machine tool park continues at such rates, the further worsening of their use will occur and the expenditures on service and repair work will increase considerably (more than 1 million machine tools will annually have to undergo overhauling alone).

Obviously, the development of the machine tool park should take a different, intensive route, that is, it is necessary to allocate a greater and greater proportion of the machine tools being produced for the replacement of obsolete and worn out machines; instead of approximately 1.5-2 percent of the machine tools, which are presently being retired from the park, 3-4 percent, and later even 5-6 percent, should be replaced annually by more productive machines, which will lead to a reduction of the park of available machines with its increasing production capacity. Here the replacement will take place primarily not by the replacement of an old machine tool with a new one at the place of its dismantling, but by the building of new enterprises which are specialized in parts and the processing method and which supply their items to tens and hundreds of enterprises and organizations of different sectors.

In examining the age characteristics and process of the replacement of the production equipment of industry, it is impossible not to come to the conclusion that the high proportion of "young" equipment is being achieved for the present not by the intensive replacement of obsolete and worn out machines, but as a result of the rapid expansion of the park. The proportion of industrial fixed capital up to 5 years old constituted on 1 January 1971 43 percent of its total value and on 1 January 1976 40 percent.

In spite of the considerable increase of the production volumes and the introduction of new equipment in the park, a tendency for the retirement of old machines to accelerate has not yet been observed. The average annual proportion of the actual retirement of the active component of the fixed production capital of USSR industry was during the Seventh Five-Year Plan 2.42 percent, the Eighth Five-Year Plan--3.16 percent, the Ninth Five-Year Plan--2.48 percent and in 1976-1977--2.2 percent.[16]

The indicated magnitude of the annual retirement of equipment does not ensure a decrease of its actual service life to the level of the standard service life. The standards of amortization deductions, which were put into effect on 1 January 1975, proceed from a shorter service life than the previous norms: the average standard service life of the fixed production capital of industry was decreased from 25.6 to 21.3 years, that of construction from 13.3 to 12.4 years. The average standard service life of machinery and equipment was shortened even more: in industry from 17.3 to 14.5 years, in construction from 10.9 to 8.3 years.

The trend toward the shortening of the standard service life, as well as toward its greater differentiation, unquestionably conforms to the demands of modern scientific and technical progress and, obviously, will be

maintained in the future. However, the actual service life of equipment, as rough estimates show, in industry on the average is longer, and in construction and agriculture is shorter than the standard service life.

Meanwhile the most efficient version of replacement presumes the approximate coincidence of the periodicity of replacement with the rate of technical progress, since in this case equipment which is not only worn out, but also obsolete is being replaced, and considerably more productive, efficient equipment is replacing it. Consequently, the acceleration of the process of replacement is an important requirement of the policy of replacing industrial equipment (and an important component of the technical policy). The further increase in the production of machines, the increase of their technical level and the intensification of their utilization are providing more and more favorable possibilities for such an acceleration. At the same time the problem of lengthening the service life of equipment by increasing its quality and improving the conditions of storage, operation and repair is especially urgent at present in agriculture and construction, as well as in a number of extractive sectors.

Under the conditions of the acceleration of scientific and technical progress the problem of bringing the rates of wear and obsolescence closer requires the intensification of the use of machines and equipment: the increase of the shift coefficient, the reduction of the downtimes, the intensification of the operating conditions and the use of all the technical potentials of machines. This is especially important in connection with the appearance of newer and newer types of expensive highly productive equipment, which is usually paid for in the standard period only with a heavy workload (2-3 full shifts). Meanwhile, the shortcomings in the organization of production, the disproportions in the structure of associated equipment, as well as such socio-economic factors, for example, as the preference for one-shift operation, are promoting a decrease of the level of the equipment workload and an increase of the capital-output ratio of production. In order to overcome the tendency for the capital-output ratio to increase, it is necessary, on the one hand, to limit the increase of the cost of new machines to the growth rate of their use value, that is, the basic effective properties. On the other hand, it is necessary to increase the rate of the specialization and concentration of the production of technologically similar products, to improve the training of machine tool operators, to perfect the organization of the production and repair of equipment and material and technical supply and the system of stimulation and to introduce various forms of the joint use of equipment by different enterprises. One of the most important tasks is to ensure the increase of the level of the shift coefficient of equipment with the use during the second and third shifts of the minimum number of workers. This is possible under the conditions of the automation of production and the performance during the first shift of the main preliminary and auxiliary operations.

Thus, the development of the tools of labor at the present stage is taking place under the influence of complicated and contradictory factors, which

influence the rate and effectiveness of this development in different directions. Under the indicated conditions the improvement of the structure of equipment (sectorial, technological, type size, age) requires, in our opinion, new methods of planned management, the transformation of the structure of machinery and equipment into a special object of national economic and sectorial planning. Such planning should ensure the solution of the set of problems examined above, as well as the realization of such directions of technical policy as the selection for introduction of the most efficient types of new mechanical equipment, the restriction of the growth rate of the output of traditional equipment for the purpose of inciting enterprises to utilize better the enormous available park of it, as well as releasing the capacities of machine building for the more rapid placement of fundamentally new equipment into production. The greater differentiation of the type sizes and modified versions of the equipment being produced for the purpose of providing every user with machines which according to the technical parameters correspond to the nature of the object of labor and the production conditions, as well as an entire set of measures on improving the use of equipment in all the sectors of the national economy are also necessary.

FOOTNOTES

1. K. Marx and F. Engels, "Soch." /Works/, Vol 23, p 191.

2. In the developed capitalist countries the production of medical equipment is increasing exceptionally rapidly. From 1965 to 1975 it increased (in current prices) in the United States from $1.0 billion to $3.4 billion, in Japan from approximately $150 million to $600 million, in the FRG from $200 million to almost $500 million. According to predictions, this sector in the next few years will occupy one of the leading places in the growth rate of production.

3. In the United States and the FRG the expenditures on combatting environmental pollution are 0.8 percent of the gross national product, in Japan they are more than 3 percent. Quite large and rapidly growing sectors for the production of purification equipment and sewage treatment facilities have been formed in the machine building of these countries.

4. ELECTRICAL WORLD, 15 February 1968.

5. See PRAVDA, 4 December 1978.

6. In the United States more than 500,000 low-power garden tractors and motorized cultivators are produced annually. When they are produced in sufficient numbers these machines can be used on the private plot, on farms, in plant growing, horticulture and others, which will make it possible not only to mechanize many of the operations now performed manually, but also to lengthen the service life of more powerful tractors.

7. See M. Vilenskiy, "On One Important Link of Scientific and Technical Progress," VOPROSY EKONOMIKI, No 8, 1969; G. Danilin, "On the Essence of the Scientific and Technical Revolution," VOPROSY EKONOMIKI, No 10, 1976; V. I. Kushlin, "Uskoreniye vnedreniya nauchnykh dostizheniy v proizvodstvo" /The Acceleration of the Introduction of Scientific Achievements in Production/, Moscow, "Ekonomika", 1976.

8. In USSR industry from 1965 to 1977 the number of installed automatic lines increased from 6,000 to 20,600, automated sections--from 2,400 to 6,700, automated shops--from 700 to 2,300, completely automated sections--from 500 to 1,700, completely automated shops--from 200 to 800 ("SSSR v tsifrakh v 1978 g." /The USSR in Figures in 1978/, Moscow, "Statistika", 1979, p 77).

9. KOMMUNIST, No 13, 1978, p 50.

10. See MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 2, 1978.

11. The average recovery period of the expenditures on measures for the introduction of new equipment by means of the annual economic impact in industry was in 1975 about 2 years, including nearly 4 years for the expenditures on measures for automation and 3.2 years for the introduction of computer hardware.

12. "Two types of physical wear of a machine occur," K. Marx indicated. "One arises from its use--as coins are worn in circulation, the other from lack of use--as a sword from lack of use rusts in the sheath" (K. Marx and F. Engels, "Soch.," Vol 23, p 415).

13. At materials-intensive works a similar result is achieved when the new equipment provides if only a small saving of materials.

14. For the heaviest machines of the textile industry the calculations, in particular, showed that with a substantial increase of the productivity of new models it is feasible to shorten the service life of looms and spinning machines from 20 to 10-15 years, while with the lack of technical progress it should be lengthened to up to 30 years (see for more detail Yu. V. Kurenkov, D. M. Palterovich, "Tekhnicheskiy progress i optimal'noye obnovleniye proizvodstvennogo apparata" /Technical Progress and the Optimum Replacement of Production Equipment/, Moscow, "Mysl'", 1975).

15. Calculations show that in the United States from 1963 to 1973 approximately three-fourths of the domestic consumption of machine tools and four-fifths of the forge and press machines were allocated for the replacement of old equipment. The increase of the park slowed sharply, and in recent years the tendency for it to decrease rapidly has been noted: during 1974-1977 the park of machine tools in the United States decreased by 13 percent, while that of forge and press machines decreased by 7 percent (AMERICAN MACHINIST, December 1978).

16. The data for the Seventh and Eighth Five-Year Plans were calculated according to the materials of the USSR Central Statistical Administration, for the Ninth Five-Year Plan and 1976 and 1977 according to the materials of the statistical yearbooks "Narodnoye khozyaystvo SSSR" /The USSR National Economy/ for the corresponding years.

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